REMARKS

In the last Office Action, the Examiner objected to the amendment filed March 10, 2005 under 35 U.S.C. §132 as introducing new matter into the originally filed disclosure. Claims 1-20 were rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. Claim 2 was objected to as being of improper dependent form. Claims 1, 3 and 5-14 were rejected under 35 U.S.C. §102(e) as being anticipated by U.S. Patent No. 6,235,590 to Daniel et al. ("Daniel"). Claims 2, 4 and 15-20 were rejected under 35 U.S.C. §103(a) as being unpatentable over Daniel. Additional art was cited of interest.

In accordance with this response, the specification has been suitably revised to provide antecedent basis for the claim language in compliance with 37 C.F.R. §1.75(d)(1). Claim 2 has been revised to depend on claim 1 to overcome the Examiner's objection under 37 C.F.R. §1.75(c). Claims 5-14 have been canceled without prejudice or admission, thereby rendering the rejection of these claims under 35 U.S.C. §112, first paragraph, moot.

Applicant most respectfully requests entry of the foregoing amendments since they merely comprise amendment of the specification to provide antecedent basis for the claim language in compliance with 37 C.F.R. §1.75(d)(1) and

amendment of claim 2 to depend on claim 1 to overcome the Examiner's objection under 37 C.F.R. §1.75(c). The subject matter of amended claim 2 has already been considered by the Examiner. In addition, the amendments substantially narrow any appealable issues because they cancel a significant number of other claims. Thus, entry of the foregoing amendments does not impose a burden on the Examiner and should not be denied.

Applicant requests reconsideration of his application in light of the following discussion.

Objection Under 35 U.S.C. §132

The Examiner objected to the amendment filed March 10, 2005 as introducing new matter into the originally filed disclosure. More specifically, the Examiner contends that the following features recited in the claims are not supported by the disclosure as originally filed:

(1) First and second gate oxide films having different thicknesses (claims 1, 3);

(2) Formation of a MOS capacitor, and a portion of the first silicon oxide film which has not been removed during the removing step comprising an insulating film of the MOS capacitor (claims 5-14); and

(3) The first gate insulating film being a silicon oxide film (claims 1, 3, 15).

Applicant respectfully disagrees with the Examiner's contention.

With respect to the feature set forth above in (2), claims 5-14 directed to this feature have been canceled without prejudice or admission, thereby rendering the objection to the subject matter recited in these claims moot.

With respect to the features set forth above in (1) and (3), applicant respectfully submits that claims 1 and 3 as originally filed provide clear support for first and second silicon oxide films having different thicknesses (see preambles in originally filed claims 1 and 3). In order to comply with the requirement of 37 C.F.R. §1.75(c), the specification (pgs. 4-5) has been amended herein only to provide antecedent basis for the feature that the first gate insulating films 3, 6 are formed of silicon oxide, as recited in original claims 1 and 3.

Moreover, in addition to the literal support in original claims 1 and 3, the subject matter corresponding to the feature set forth above in (1) is also supported by Figs. 1A and 1D of the drawings as originally filed. As pointed out by the Court in In re Wolfensperger, 133 USPQ 537, 542 (CCPA 1962):

> The practical, legitimate inquiry in each case of this kind is what the drawing in fact discloses to one skilled in the art. Whatever it does disclose may be added to the specification in words without

> violation of the statute and rule which prohibit "new matter," 35 U.S.C. 132, Rule 118, for the simple reason that what is originally disclosed cannot be "new matter" within the meaning of this law. If the drawing, then, contains the necessary disclosure, it can "form the basis of a valid claim."
>
> This is not to say that the Patent Office, before permitting a patent to issue, cannot at the same time enforce compliance with another requirement, found in its Rule 75(d), that "the terms and phrases used in the claims must find clear support or antecedent basis in the description so that the meaning of the terms in the claims may be ascertainable by reference to the description." This matter is further elucidated in MPEP 608.01(o) which clearly contemplates that it may be necessary to change or add to the language of the specification so as to provide proper support for the language of "new claims." It says:
>
> While an applicant is not limited to the nomenclature used in the application as filed, yet whenever by amendment of his claims, he departs therefrom, he should make appropriate amendment of his specification so as to have therein clear support or antecedent basis for the new terms appearing in the claims.

In this case, Fig. 1A shows the first silicon oxide film 3 and Fig. 1D shows the second silicon oxide film 6. It is clear from Figs. 1A and 1D as originally filed that the first and second silicon oxide films 3, 6 have <u>different</u> thicknesses (i.e., the second silicon oxide film 6 has a thickness greater than that of the first silicon oxide film

3). In the March 10 response, applicant amended page 5 of the specification to describe that which is explicitly illustrated in the drawings, i.e., the formation of first and second silicon oxide films 3, 6 having different thicknesses.

Thus the amendments to the specification made herein and the amendments to the specification and claims made in the March 10 response do not constitute the introduction of impermissible new matter. The feature of the first and second gate insulating films being formed of silicon oxide is supported by the disclosure in originally filed claims 1 and 3. The feature of the first and second silicon oxide films having different thicknesses is supported by the disclosure in originally filed claims 1 and 3 and Figs. 1A, 1D. The amendments to the specification expressly comply with 37 C.F.R. §1.75(c) and with the suggestion in Wolfensperger regarding the requirement for the specification to provide an antecedent basis for the subject matter recited in the claims.

Accordingly, applicant respectfully submits that the Examiner's objection to the amendment filed March 10, 2005 has been overcome and should be withdrawn.

Rejection Under 35 U.S.C. §112, First Paragraph

Claims 1-20 were rejected under 35 U.S.C. §112, first paragraph. Relying on the "written description"

requirement of 35 U.S.C. §112, first paragraph, the Examiner contends that claims 1-20 contain subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed, had possession of the claimed invention. The subject matter objected to by the Examiner is as set forth above in (1)-(3) for the objection under 35 U.S.C. §132. Applicant respectfully traverses this contention.

The purpose of the written description requirement of 35 U.S.C. §112, first paragraph, is to ensure that the inventor had possession of the invention as of the filing date. In re Wertheim, 191 USPQ 90, 96 (CCPA 1976). In deciding whether or not the written description requirement has been satisfied, the content of the drawings may be considered. In re Kaslow, 217 USPQ 1089, 1096 (Fed. Cir. 1983).

With respect to the feature set forth above in (2) relating to the objection under 35 U.S.C. §132, claims 5-14 directed to this feature have been canceled without prejudice or admission, thereby rendering the rejection of these claims under 35 U.S.C. §112, first paragraph, moot.

With respect to the features set forth above in (1) and (3) corresponding to the objection under 35 U.S.C. §132,

claims 1 and 3 as originally filed provide clear support for first and second silicon oxide films having different thicknesses (see preambles in originally filed claims 1 and 3). Figs. 1A and 1D as originally filed also provide support for first and second silicon oxide films having different thicknesses, as set forth above for the objection under 35 U.S.C. §132. In order to comply with 37 C.F.R. §1.75(d)(1), the specification has been amended herein to provide literal antecedence for the first and second gate insulating films being made of silicon oxide and in the March 10 response to provide literal antecedence for the first and second silicon oxide films having different thicknesses. Thus the disclosure of first and second silicon oxide films having different thicknesses in the specification and drawings as originally filed would reasonably convey to one skilled in the relevant art that the inventor, at the time the application was filed, had possession of the presently claimed invention.

In view of the foregoing, applicant respectfully submits that claims 1-4 and 15-20 are in full compliance with the "written description" requirement of 35 U.S.C. §112, first paragraph, and requests that the rejection of claims 1-4 and 15-20 under 35 U.S.C. §112, first paragraph, be withdrawn.

Brief Summary of the Invention

The present invention is directed to a method for manufacturing a semiconductor device, such as a MOS transistor.

Figs. 2A-2E show a conventional method for manufacturing a semiconductor device. As described in the specification (pgs. 1-3), a first oxide film 11 is formed on a surface of a silicon substrate 9 (Fig. 2A) and is then subjected to a nitriding treatment (Fig. 2B). As a result of the nitriding treatment, silicon oxynitride 12 is formed at an interface between the surface of the silicon substrate 9 and the first oxide film 11. The first oxide film 11 is then removed from a portion of the surface of the silicon substrate 9 using a hydrofluoric acid (Fig. 2C) for the purpose of preparing the portion of the surface of the silicon substrate so that a second oxide film 14 can be formed thereon (Fig. 2D).

However, the use of the hydrofluoric acid alone has been insufficient to completely remove the silicon oxynitride 12 formed at the interface between the portion of the surface of the silicon substrate 9 and the first oxide film 11. As a result, the silicon oxynitride 12 remains on the portion of the surface of the silicon substrate 9 from which the first oxide film 11 has been removed (see Fig. 2C). The remaining

silicon oxynitride 12 acts as an inhibitor against oxidation during formation of the second oxide film 14 which is formed by thermal oxidation, thereby affecting the reliability of the second oxide film 14.

The present invention overcomes the drawbacks of the conventional art. Figs. 1A-1E show an embodiment of a method for manufacturing a semiconductor device according to the present invention embodied in the claims. A first silicon oxide film 3 is first formed on a semiconductor substrate 1 (Fig. 1A). The first silicon oxide film is then subjected to a nitriding treatment so that silicon oxynitride 4 forms at an interface between the semiconductor substrate 1 and the first silicon oxide film 3 (Fig. 1B). According to the present invention, the first silicon oxide film 3 is then completely removed from a portion of the semiconductor substrate 1 using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride 12 formed at the interface between the portion of the semiconductor substrate 1 and the first silicon oxide film 3 is also completely removed (Fig. 1C). A second silicon oxide film 6 is then formed on the portion of the semiconductor substrate 1 from which the first silicon oxide film 3 and the silicon oxynitride 12 have been completely removed (Fig. 1D).

By the foregoing manufacturing method according to the present invention, the silicon oxynitride which forms at the interface between the semiconductor substrate and the first silicon oxide film during the nitriding treatment is completely removed using the ammonia-hydrogen peroxide solution. As a result, deterioration of the second silicon oxide film, which is subsequently formed on the portion of the semiconductor substrate from which the first silicon oxide film and the silicon oxynitride are completely removed, is effectively prevented.

Traversal of Prior art Rejections

Rejection Under 35 U.S.C. §102

Claims 1 and 3 were rejected under 35 U.S.C. §102(e) as being anticipated by Daniel. Applicant respectfully traverses this rejection and submits that independent claims 1 and 3 recite subject matter which is not identically disclosed or described in Daniel.

Independent claim 1 is directed to a method for manufacturing a semiconductor device and requires the steps of forming a first silicon oxide film having a first thickness on a silicon substrate, nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the silicon substrate and the first silicon oxide film, removing

the first silicon oxide film from a part of the silicon substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed, and forming a second silicon oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film and the silicon oxynitride are removed, the second silicon oxide film having a second thickness different from the first thickness. No corresponding combination of steps is disclosed or described by Daniel.

Daniel discloses a method for manufacturing a semiconductor device having devices with gate insulating layers 16, 18 having different thicknesses (Figs. 2A-2G). Prior to forming the gate insulating layers 16, 18 on a surface 36 of a substrate 20, the surface 36 of the substrate 20 is cleaned using standard SC1 and SC2 techniques (col. 3, lines 23-30; Fig. 2A). Thereafter, a first silicon oxynitride layer 38 is formed on the surface 36 of the substrate 20 (Fig. 2B). A photoresist pattern 40 is then formed over the first silicon oxynitride layer 38 (Fig. 2C). After formation of the photoresist pattern 40, the first silicon oxynitride layer 38 is etched (Fig. 2D). As shown in Fig. 2E, the photoresist

pattern 40 is stripped, causing the formation of a thin chemical oxide layer 42 on the surface 36 of the substrate 20 (Fig. 2E). The surface 36 of the substrate is then cleaned to remove the chemical oxide layer 42 using standard SC1 and SC2 techniques (Fig. 2F). Daniel discloses that only about 3-4 angstroms are removed from the remaining first oxynitride layer 38 during the substrate cleaning process in Fig. 2F (col. 4, lines 15-18). A second silicon oxynitride layer 44 is then formed over the substrate (Fig. 2G), including over the first oxynitride layer 38 (col. 4, lines 19-26).

However, Daniel does not disclose or describe the combination of steps recited in independent claim 1. First, claim 1 requires the steps of forming a first silicon oxide film on the surface of a silicon substrate, completely removing the first silicon oxide film from a part of the surface of the silicon substrate, and forming a second silicon oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film is removed. The Examiner contends that the elements denoted by reference numerals 36 and 44 in Daniel correspond to the first and second oxide films recited in claim 1. However, as set forth above, and contrary to the Examiner's contention, numeral 36 in Daniel denotes the surface of the substrate 20, and numeral 44 denotes an oxynitride layer. Daniel does not disclose or

describe the complete removal of a first silicon oxide film from a part of the silicon substrate, and the formation of a second silicon oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film is removed, as recited in claim 1.

Furthermore, claim 1 requires the formation of silicon oxynitride at an interface between the silicon substrate and the first silicon oxide film during a nitriding step, and the subsequent complete removal of the silicon oxynitride using a chemical containing at least an ammonia-hydrogen peroxide solution. Daniel discloses the formation and subsequent etching of a first oxynitride layer 38. However, contrary to the Examiner's contention, the first oxynitride layer is not completely removed. More specifically, Daniel discloses that during the substrate surface cleaning process, "only about 3-4 angstroms (A) are removed from the remaining first oxynitride layer 38" (col. 4, lines 15-18). Furthermore, Daniel discloses that a second oxynitride layer 44 "is grown over ... the first oxynitride layer 38" (col. 4, lines 22-26), that is, the first oxynitride layer 38 is not completely removed because it is still present when the second oxynitride layer 44 is subsequently formed.

Moreover, Daniel discloses the use of a standard SC1 technique which involves the use of ammonia-hydrogen peroxide.

However, in Daniel the standard SC1 technique is used to clean the surface 36 of the substrate to remove any residual oxide as well as surface contaminants (col. 3, lines 24-30), and later to clean the surface of the substrate 36 to remove the chemical oxide layer 42 (col. 4, lines 9-12). Daniel does not disclose or describe the use of ammonia-hydrogen peroxide for the purpose of removing silicon oxynitride formed at an interface between the silicon substrate and a first silicon oxide film, as recited in claim 1.

Moreover, claim 1 requires the formation of first and second silicon oxide films having different thicknesses. The Examiner contends that the film 44 in Daniel corresponds to a second silicon oxide film which is formed (i.e., grown) with a thickness greater than a first silicon oxide film, citing column 4, lines 36-45 in Daniel in support of this contention. As set forth above, Daniel does not disclose or describe the first and second silicon oxide films recited in claim 1. Additionally, in column 4, lines 36-45, Daniel merely discloses that the rate of growth of the second oxynitride layer 44 on the bare silicon surface 36 tends to be greater than the rate of growth of the second oxynitride layer 44 on the first oxynitride layer 38. Stated otherwise, column 4, lines 36-45 of Daniel merely discloses that the thicknesses of the portions of the second oxynitride layer 44 (i.e., the

same layer) on the bare silicon surface 36 and on the first oxynitride layer 38 are different. This disclosure clearly does not relate at all to the formation of independent silicon oxide layers having different thicknesses, as required by claim 1.

Independent claim 3 is also directed to a method for manufacturing a semiconductor device and requires the steps of forming a first silicon oxide film having a first thickness on a silicon substrate, nitriding the first silicon oxide film so that silicon oxynitride forms at an interface between the silicon substrate and the first silicon oxide film, removing the first silicon oxide film from a part of the silicon substrate, washing the part of the silicon substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the part of the silicon substrate and the first silicon oxide film is completely removed, and forming a second silicon gate oxide film in at least a portion of the part of the silicon substrate from which the first silicon oxide film and the silicon oxynitride are removed, the second silicon oxide film having a second thickness different from the first thickness. No corresponding combination of steps is disclosed or described by Daniel as set forth above for independent claim 1.

In the absence of the foregoing disclosure recited in independent claims 1 and 3, anticipation cannot be found. See, e.g., W.L. Gore & Associates v. Garlock, Inc., 220 USPQ 303, 313 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("Anticipation requires the disclosure in a single prior art reference of each element of the claim under consideration"); Continental Can Co. USA v. Monsanto Co., 20 USPQ2d 1746, 1748 (Fed. Cir. 1991) ("When more than one reference is required to establish unpatentability of the claimed invention anticipation under § 102 can not be found"); Lindemann Maschinenfabrik GmbH v. American Hoist & Derrick Co., 221 USPQ 481, 485 (Fed. Cir. 1984) (emphasis added) ("Anticipation requires the presence in a single prior art reference disclosure of each and every element of the claimed invention, arranged as in the claim").

Stated otherwise, there must be no difference between the claimed invention and the reference disclosure, as viewed by a person of ordinary skill in the field of the invention. This standard is clearly not satisfied by Daniel for the reasons stated above. Furthermore, Daniel does not suggest the claimed subject matter and, therefore, would not have motivated one skilled in the art to modify Daniel's manufacturing method to arrive at the claimed invention.

In view of the foregoing, applicant respectfully requests that the rejection of claims 1 and 3 under 35 U.S.C. §102(e) as being anticipated by Daniel be withdrawn.

Rejection Under 35 U.S.C. §103(a)

Claims 2, 4 and 15-20 were rejected under 35 U.S.C. §103(a) as being unpatentable over Daniel. Applicant respectfully traverses this rejection and submits that the teachings of Daniel do not disclose or suggest the subject matter recited in claims 2, 4 and 15-20.

Daniel does not disclose or suggest the subject matter recited in independent claims 1 and 3 as set forth above for the rejection of claims 1 and 3 under 35 U.S.C. §102(e). Claims 2 and 4 depend on and contain all of the limitations of independent claims 1 and 3, respectively, and, therefore, distinguish from the references at least in the same manner as claims 1 and 3.

Independent claim 15 is directed to a method for manufacturing a semiconductor device and requires the steps of forming a first silicon oxide film on a semiconductor substrate, subjecting the first silicon oxide film to an atmosphere containing at least an ammonia gas so that silicon oxynitride forms at an interface between the semiconductor substrate and the first silicon oxide film, completely removing the first silicon oxide film and the corresponding

silicon oxynitride from a portion of the semiconductor substrate, and forming a second silicon oxide film on the portion of the semiconductor substrate from which the first silicon oxide film and the silicon oxynitride have been completely removed. No corresponding combination of steps are disclosed or suggested by Daniel as set forth above for independent claim 1 in the rejection under 35 U.S.C. §102(e). For example, Daniel does not address at all the complete removal of silicon oxynitride formed at an interface between a semiconductor substrate and a first silicon oxide film, and further the complete removal of silicon oxynitride which is formed as a result of subjecting the first silicon oxide film to an atmosphere containing at least an ammonia gas, as required by independent claim 15.

Claims 16-20 depend on and contain all of the limitations of independent claim 15 and, therefore, distinguish from the prior art of record at least in the same manner as claim 15.

Moreover, there are separate grounds for patentability of several of new dependent claims 16-20.

Claim 16 includes the additional limitation that the removing step comprises a first step of completely removing the first silicon oxide film from the portion of the semiconductor substrate, and a second step of washing the

portion of the semiconductor substrate from which the first silicon oxide film has been removed using a chemical containing at least an ammonia-hydrogen peroxide solution to completely remove the silicon oxynitride formed at the interface between the portion of the semiconductor substrate and the first silicon oxide film. No corresponding step is disclosed or suggested by the prior art of record.

Claim 18 includes the additional limitation that the removing step comprises the step of removing the first silicon oxide film from the portion of the semiconductor substrate using a chemical containing at least an ammonia-hydrogen peroxide solution so that the silicon oxynitride formed at the interface between the portion of the semiconductor substrate and the first silicon oxide film is completely removed. Again, no corresponding step is disclosed or suggested by the prior art of record.

Claim 20 includes the additional limitation that the semiconductor device comprises a MOS transistor, and that the first silicon oxide film comprises a gate oxide film of the MOS transistor. No corresponding step is disclosed or suggested by the prior art of record.

In view of the foregoing, applicant respectfully requests that the rejection of claims 2, 4 and 15-20 under 35 U.S.C. §103(a) as being unpatentable over Daniel be withdrawn.

Applicant most respectfully requests entry of the foregoing amendments since they merely comprise amendment of the specification to provide antecedent basis for the claim language in compliance with 37 C.F.R. §1.75(d)(1) and amendment of claim 2 to depend on claim 1 to overcome the Examiner's objection under 37 C.F.R. §1.75(c). The subject matter of amended claim 2 has already been considered by the Examiner. In addition, the amendments substantially narrow any appealable issues because they cancel a significant number of other claims. Thus, entry of the foregoing amendments does not impose a burden on the Examiner and should not be denied.

In view of the foregoing amendments and discussion, the application is believed to be in allowable form. Accordingly, entry of this amendment and favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

ADAMS & WILKS
Attorneys for Applicant

By: Bruce L. Adams
Bruce L. Adams
Reg. No. 25,386

50 Broadway
31st Floor
New York, NY 10004
(212) 809-3700

MAILING CERTIFICATE

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Debra Buonincontri
Name

Debra Buonincontri
Signature

JULY 6, 2005
Date